

# **Second Tier Review Petition for the Operation of the Core Sampler in High Purge Gas Mode**

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## EXECUTIVE SUMMARY

The U.S. Department of Energy and Tank Operations Contract manager Washington River Protection Solutions, LLC proposes operation of the core sampling system in high purge gas mode in support of tank waste characterization and future Tank Farm operational activities at the Hanford Site located in Benton County, Washington. All projects with emissions of air toxics defined in *Washington Administrative Code 173-460-150, Table of Acceptable Source Impact Level, Small Quantity Emission Rate and De Minimis Emission Values*, that exceed the de minimis levels are required to submit a first tier review. A first tier review, Criteria & Toxics Air Emissions Notice of Construction for the Operation of the Core Sampling System in High Purge Gas Mode, has been submitted to the Washington State Department of Ecology Nuclear Waste Program. If modeled concentrations exceed the acceptable source impact levels defined in *Washington Administrative Code 173-460-150* a second tier review or Health Impacts Analysis (HIA) is required. This document serves as a second tier petition and a Health Impacts Analysis pursuant to the requirements of *Washington Administrative Code 173-460-090, Second Tier Review*.

The estimated emissions and atmospheric modeling performed showed that only dimethyl mercury was found to be above the acceptable source impact level. The purpose of this document is to evaluate whether dimethyl mercury emissions from the proposed Core Sampling System could pose a potentially unacceptable health risk to local populations. A previous HIA was conducted and approved by the Washington State Department of Ecology for the 241-SY, 241-AP, 241-AY/AZ Tank Farm Ventilation System Upgrades (Kadlec, M., Ogulie, D., Bowman, C., *Technical Support Document for Second Tier Review 241-SY, 241-AP, 241-AY/AZ Tank Farm Ventilation System Upgrades at the Hanford Site, Benton County, Washington*). This Health Impacts Analysis follows the previous HIA regarding the dimethyl mercury emissions using the two pathways for human exposure that would result in the highest exposure to the public was inhalation and ingestion of plants. The first exposure scenario was a 30-year mother-child living at the point of maximum 24-hour concentration and deposition, the second was a 70-year resident scenario living at the location of the nearest resident. This evaluation is not intended to address all human exposure to dimethyl mercury or mercury in south central Washington State.

To ensure that the risks to the public are overestimated rather than underestimated, a conservative approach was taken. The process followed is listed below:

1. Estimate emissions from the Core Sampler ventilation systems.
2. Identify sensitive populations
3. Perform air modeling to predict ambient air concentrations from the ventilation systems
4. Perform air modeling to predict deposition onto plants from the ventilation systems
5. Calculate the total inhalation exposure from the operation of the ventilation systems
6. Calculate the total ingestion exposure from deposition on plants from operation of the ventilation systems
7. Calculate the total hazard from the ventilation systems.

This risk evaluation used conservative assumptions to ensure that the risk was an overestimation of the potential health impacts. Dimethyl mercury is a neurotoxin and studies have shown that it transforms into methyl mercury in the body (Ostlund, 1969). Due to the limited toxicological data for dimethyl mercury, toxicity data for methyl mercury toxicity data was used.

The maximum 24-hour modeled offsite dimethyl mercury concentration was  $5.3\text{E-}09\text{ }\mu\text{g}/\text{m}^3$ , there is limited atmospheric background data on dimethyl mercury, a mean for Antarctica was measured to be  $4.0\text{E-}05\text{ }\mu\text{g}/\text{m}^3$  (de Mora et al., *Baseline Atmospheric Mercury Studies at Ross Island*, Antarctica, 1993) and a mean for Seattle was  $3.0\text{E-}06\text{ }\mu\text{g}/\text{m}^3$  (Prestbo et al., *A Global View of the Sources and Sinks for Atmospheric Organic Mercury*, 1996). A previous analysis of dimethyl mercury emissions from Hanford modeled a peak offsite 24-hour concentration of  $7.7\text{E-}08\text{ }\mu\text{g}/\text{m}^3$  (RPP-ENV-48231, *Second Tier Review Petition for the Operation of the 241-SY, 241-AP, and 241-AY/AZ Tank Farm Ventilation System Upgrades*). This is no more than a 0.2 percent increase above the existing background, airborne concentrations are likely to be lower due to conservative assumptions.

The National Research Council recommended a reference dose for methyl mercury of  $0.1\text{ }\mu\text{g}/\text{kg}$  body weight per day to protect the most sensitive populations which are developing fetuses. The 30-year mother-child calculated exposure from the exhausters from inhalation and ingestion of dimethyl mercury is  $2.6\text{E-}08\text{ }\mu\text{g}/\text{kg}$  body weight per day. The 70-year resident calculated exposure from the exhausters from inhalation and ingestion of dimethyl mercury is  $2.4\text{E-}09\text{ }\mu\text{g}/\text{kg}$  body weight per day. The conservative assumptions made in this analysis resulted in an overestimation of the potential health impacts from dimethyl mercury emissions. The calculated hazard quotient for a mother-child 30-year exposure is  $2.6\text{E-}07$ , a level well below that threshold value of 1.0. The calculated hazard quotient for a 70-year resident exposure is  $2.4\text{E-}08$ , a level also well below that threshold value of 1.0. Both of these hazard quotients indicate that DMM emissions from the proposed core samplers should not pose any threat to the public.

Based upon the available literature and very low emissions and resulting ambient concentrations the emissions of dimethyl mercury from the proposed new core samplers should not pose a risk to the public.

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## LIST OF TERMS

AOP	Air operating permit
ASIL	Acceptable source impact level
BACT	Best Available Control Technology
DMM	Dimethyl mercury
CAS	Chemical Abstract Service
DOE	Department of Energy
DST	Double-shelled tank
Ecology	Washington State Department of Ecology
HMS	Hanford Meteorological Station
HQ	Hazard Quotient
MeHg	Methyl mercury
SST	Single-shelled tank
TAP	Toxic Air Pollutant
tBACT	BACT for toxics
TWINS	Tank Waste Information Network System
WAC	<i>Washington Administrative Code</i>
WRPS	Washington River Protection Solutions, LLC
WTP	Waste Treatment and Immobilization Plant

## Units

scfm	standard cubic feet per minute
kg	kilogram
mi	miles
ng	nanograms
µg	micrograms

## **1.0 PROJECT SUMMARY**

The U.S. Department of Energy (DOE) and its Tank Operations Contractor (TOC) manager, Washington River Protection Solutions, LLC (WRPS) are proposing construction and operation of new Core Sampling ventilation systems for use in passively ventilated tanks at the Tank Farms at the Hanford Site in Benton County, Washington. All projects with emissions of toxics in *Washington Administrative Code* (WAC) 173-460-150 that exceed the de minimis levels are required to submit a first tier review. A first tier review, Criteria & Toxics Air Emissions Notice of Construction for the Core Sampling System in High Purge Gas Mode, has been submitted to the Washington State Department of Ecology (Ecology) Nuclear Waste Program. If modeled ambient concentrations exceed the acceptable source impact levels (ASIL) in WAC 173-460-150 a second tier review or Health Impacts Analysis (HIA) is required. This document serves as a second tier petition and a HIA pursuant to the requirements of WAC 173-460-090 and follows the format of the previous HIA that was submitted and approved by Ecology (Kadlec, M., Ogulie, D., Bowman, C., *Technical Support Document for Second Tier Review 241-SY, 241-AP, 241-AY/AZ Tank Farm Ventilation System Upgrades at the Hanford Site, Benton County, Washington*).

The previous Core Sampling Systems were beyond their useful life and are being replaced with new systems to take new samples to sample and characterize the waste in the Hanford Tank Farms. Core sampling is used to obtain a core of the waste, the high purge gas mode with an exhaustor is used when the density of the waste is such that normal low flow mode cannot remove sufficient heat during sampling. The high purge gas provides additional cooling for the drill bit and a portable exhaustor is used for passively ventilated tanks to ensure that the tanks are not over pressurized during sampling. Core Sampling in high purge gas mode is a short duration activity, the portable exhaustor is only turned on when the purge gas is turned on, the estimated total hours of operation for up to two samplers is 300 hours per year.

### **1.1 REPORT PURPOSE**

The purpose of this report is to document the analysis and evaluation of the potential human health related impacts of dimethyl mercury (DMM) emissions and offsite ambient concentrations from the proposed Core Sampling Systems in High Purge Gas Mode ventilation systems at the Hanford Site to support sampling of the waste tanks. This study is intended to determine if the DMM emissions from the exhaustors pose an unacceptable risk to the public. This evaluation is not intended to address all human exposure to dimethyl mercury or mercury in south central Washington.

### **1.2 HANFORD TANK FARM HISTORY**

The Hanford Site is located in south central Washington State in Benton County along the Columbia River and is approximately 586 square miles in size as shown in Figure 1. The mission of the Hanford Site from 1943 to 1988 was defense-related nuclear research, development, and weapons production. Nine nuclear reactors along the Columbia River at the site were used to produce plutonium. The site also had facilities in the Central Plateau, called the 200 Areas, used to extract the dissolved and irradiated reactor fuel for weapons production. Underground single-shell tanks (SSTs) were built to store the radiological and chemical waste from plutonium production beginning in 1943. One hundred and forty nine SSTs made of



carbon steel surrounded by concrete were built ranging in volume from 55,000 gallons to approximately 1 million gallons. Beginning in the 1960s after many of the single-shell tanks began to leak, 28 DSTs were built.

Since the last reactor was shut down in 1986 the site mission has been environmental remediation and clean up. Waste stored in the tanks consists of hazardous chemicals regulated under the *Resource Conservation and Recovery Act (RCRA) of 1976* and radioactive chemicals regulated under the *Atomic Energy Act of 1954*. In 1989 the DOE, U.S. Environmental Protection Agency (EPA) and Ecology agreed to the process and the required actions to comprehensively cleanup the Hanford Site (*Hanford Site Federal Facility Agreement and Consent Order*). The current mission to clean up the 200 Areas includes moving the waste from the SSTs to the DSTs to prevent any further leakage, retrieving and treating waste from all 177 underground tanks and ancillary equipment and disposing of the waste in compliance with applicable regulatory requirements (MGT-PM-PL-10, *Protect Execution Plan for the River Protection Tank Farms Project*).

### **1.3 CORE SAMPLING PERMITTING HISTORY**

The first NOC for the Rotary Mode Core Samplers was submitted in 1993 (DOE/RL 93-41) and the Ecology approval order was NOC-93-04, that approval was cancelled in 1999. A NOC was submitted for two additional Rotary Core Mode Samplers and the modification of the first one (DOE/RL-94-117) were approved and the existing one modified with approval order NWP 95-RMCS(3). DOE/RL-94-117 was modified in 1998 (DOE/RL-94-117, Rev. 1) and NWP 95-RMCS(3) was replaced with DE98NWP-005 which was cancelled in 2005.

## **2.0 FACILITY IDENTIFICATION AND LOCATION**

The tank farms are located at:

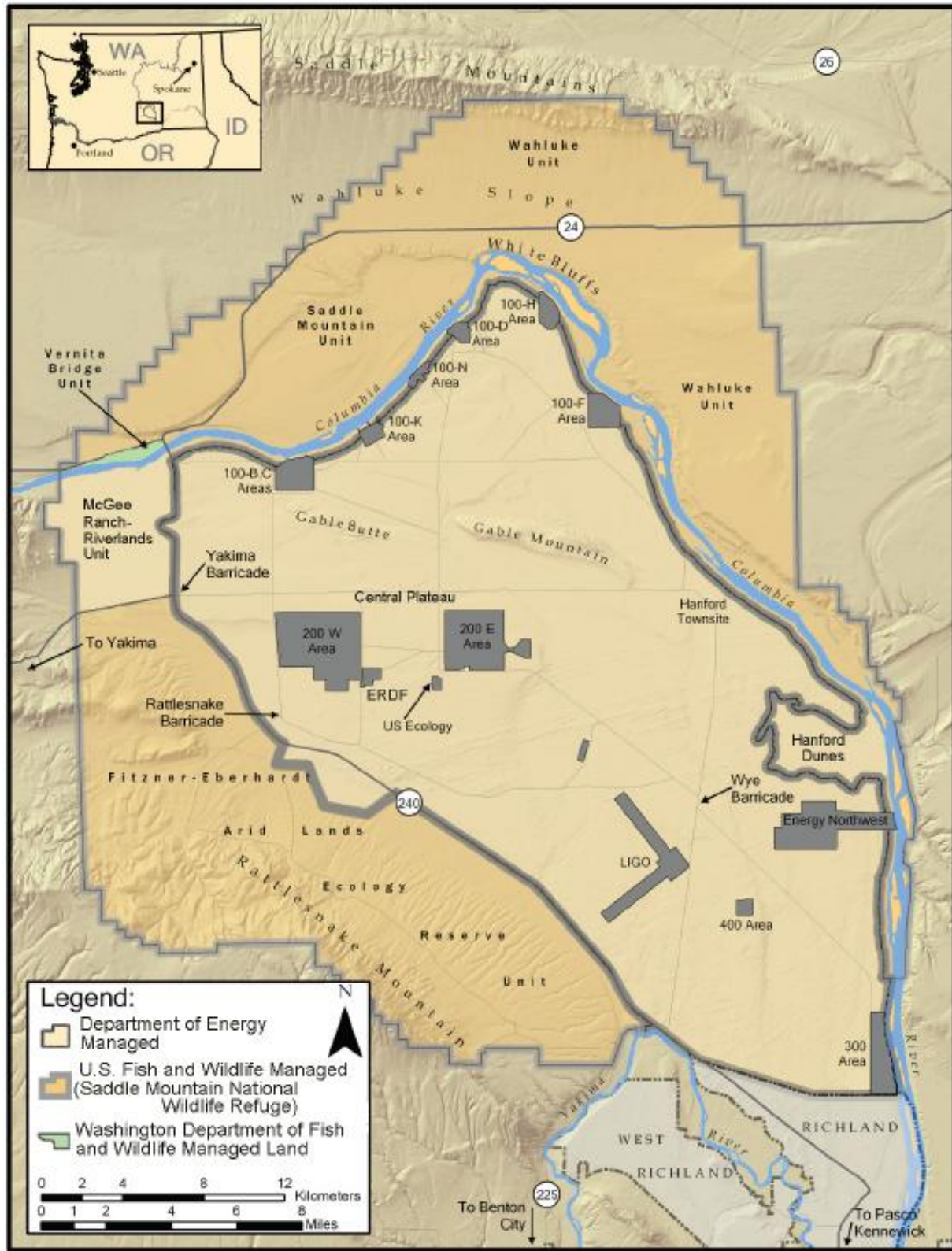
U.S. Department of Energy, Office of River Protection  
Hanford Site  
200 East and West Area Tank Farms  
Richland, WA 99352

The waste tanks are located in the 200 East and West Areas of the Hanford Site (See Figure 1 and 2). Table 1 below lists the locations of the tank farms that are at the far north and south ends of the 200 West and 200 East Areas that were used to model the emissions due to their proximity to the site boundaries.

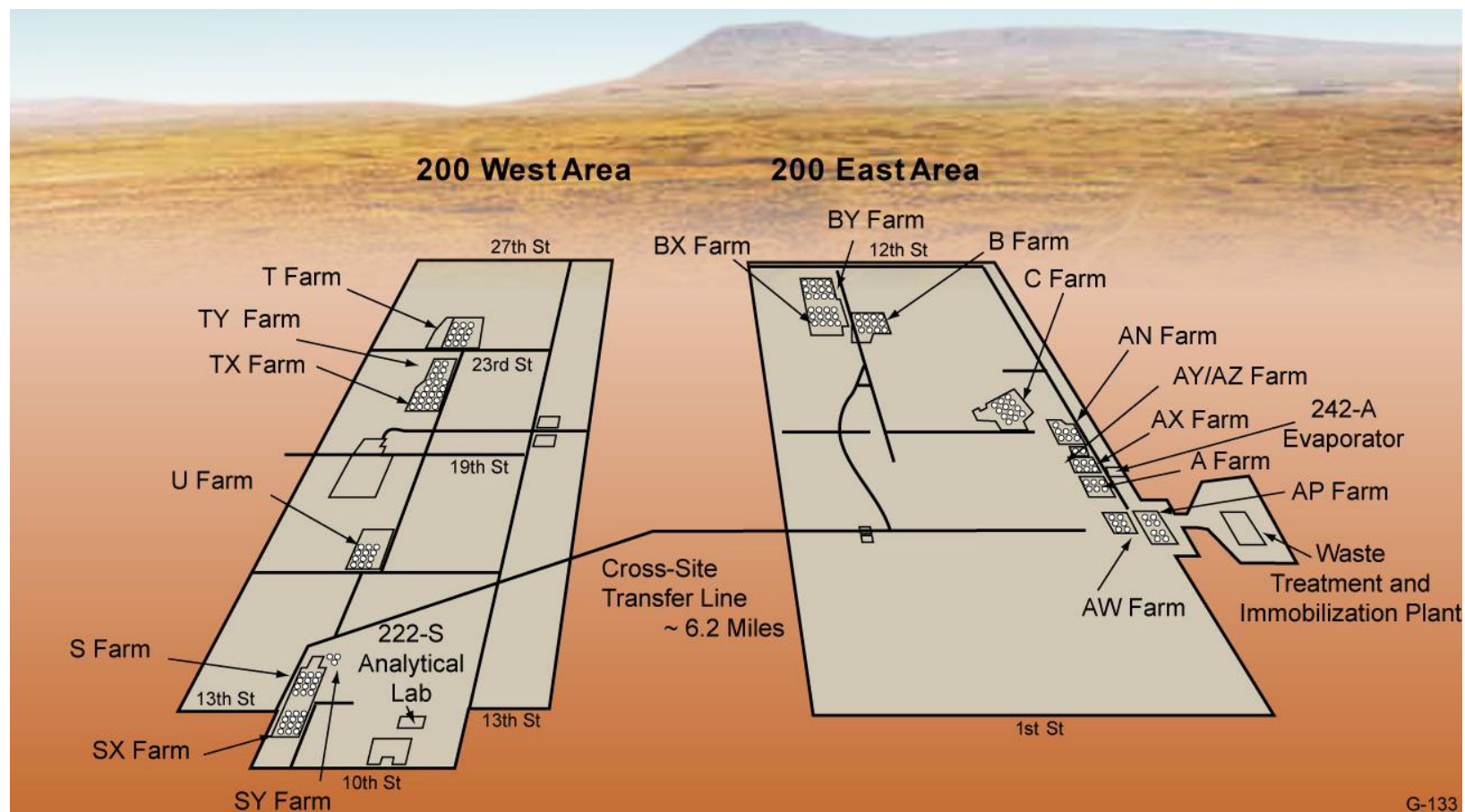
**Table 1. Tank Farm Locations.**

<b>Tank Farm</b>	<b>Latitude</b>	<b>Longitude</b>
A	46° 33' 12" N	119° 31' 02" W
BX	46° 33' 50" N	119° 32' 27" W
T	46° 33' 34" N	119° 37' 48" W
SX	46° 32' 14" N	119° 37' 48" W

Figure 1: Map of the Hanford Site.



**Figure 2. Location of all Single- and Double-Shell Tank Farms in 200 East and 200 West Areas of the Hanford Site.**



## 2.1 CORE SAMPLER VENTILATION SYSTEMS

The core sampling system is a platform-mounted unit able to be set on any tank. This system can be operated in low purge gas flow mode ( $\leq 10$  scfm) without an exhauster or high purge gas flow ( $> 10$  scfm) mode with a portable exhauster and is capable of penetrating hardened tank wastes.

To obtain a sample, the drill string containing the sampler will be drilled or pushed into the waste. The core sampler dimensions are approximately 2-inch diameter by 40-inches long and can obtain a 19-inch sample. A core sample is made up of separate core segments (1-inch diameter) with the number of segments depending on the depth of solids. A piston inside the sampler creates a vacuum and draws the waste into the sampler. The sampler will close once the sample is obtained, trapping the sample and sealing the bottom of the core barrel. The barrier fluid and a seal on the bottom of the sampler are designed to prevent back flow of tank waste into the drill string. This protects the air pathway out of the tank.

When the system is in high purge gas flow mode, a purge gas with a flow rate up to a maximum of 120 (scfm) air will be injected to maintain pressure in the drill string for cooling and cleaning the drill bit and to prevent waste intrusion into the drill string while drilling (RPP-SPEC-42205, *Performance Specification for the Modified Core Sampling System*).

An exhauster (with a nuclear grade HEPA filter) and accompanying stack will be necessary to actively ventilate SSTs or other tanks without active ventilation to control potentially unsafe pressurization and generation of radioactive aerosols. The purge air and the exhauster will only be operated for a short duration during the sampling of the tanks; total estimated operation is 300 hours per year for all systems. If necessary to operate the core sampler system in a DST or another actively ventilated tank, exhauster capabilities will not be required and the active ventilation system will be used.

The schedule for initial operation of the core sampling system is in 2014 and sampling will continue until the end of the tank cleanup work, currently projected to be 2052. The activities proposed within this NOC will negligibly increase criteria and toxic air pollutant emissions during tank waste sampling activities.

The HEPA filters are abatement equipment required by the Washington State Department of Health (WDOE) to control particulate radionuclide emissions. The HEPA filters are nuclear grade with a minimum 99.95% efficiency for a polydispersed aerosol with an approximate droplet size distribution that is 99% less than 3.0  $\mu\text{m}$ , 50% less than 0.7  $\mu\text{m}$ , and 10% less than 0.4  $\mu\text{m}$ . The HEPA filters are tested in accordance with ANSI N510 *Testing of Nuclear Air Treatment Systems*. Actual filter measurements with tank waste radionuclides show that individual filters are approximately 99.998% efficient which is at the limit of detection equipment (RPP-4826, *Experience with Aerosol Generation During Rotary Mode Core Sampling in the Hanford Single Shelled Waste Tanks*).

## **2.2 HANFORD METEOROLOGY**

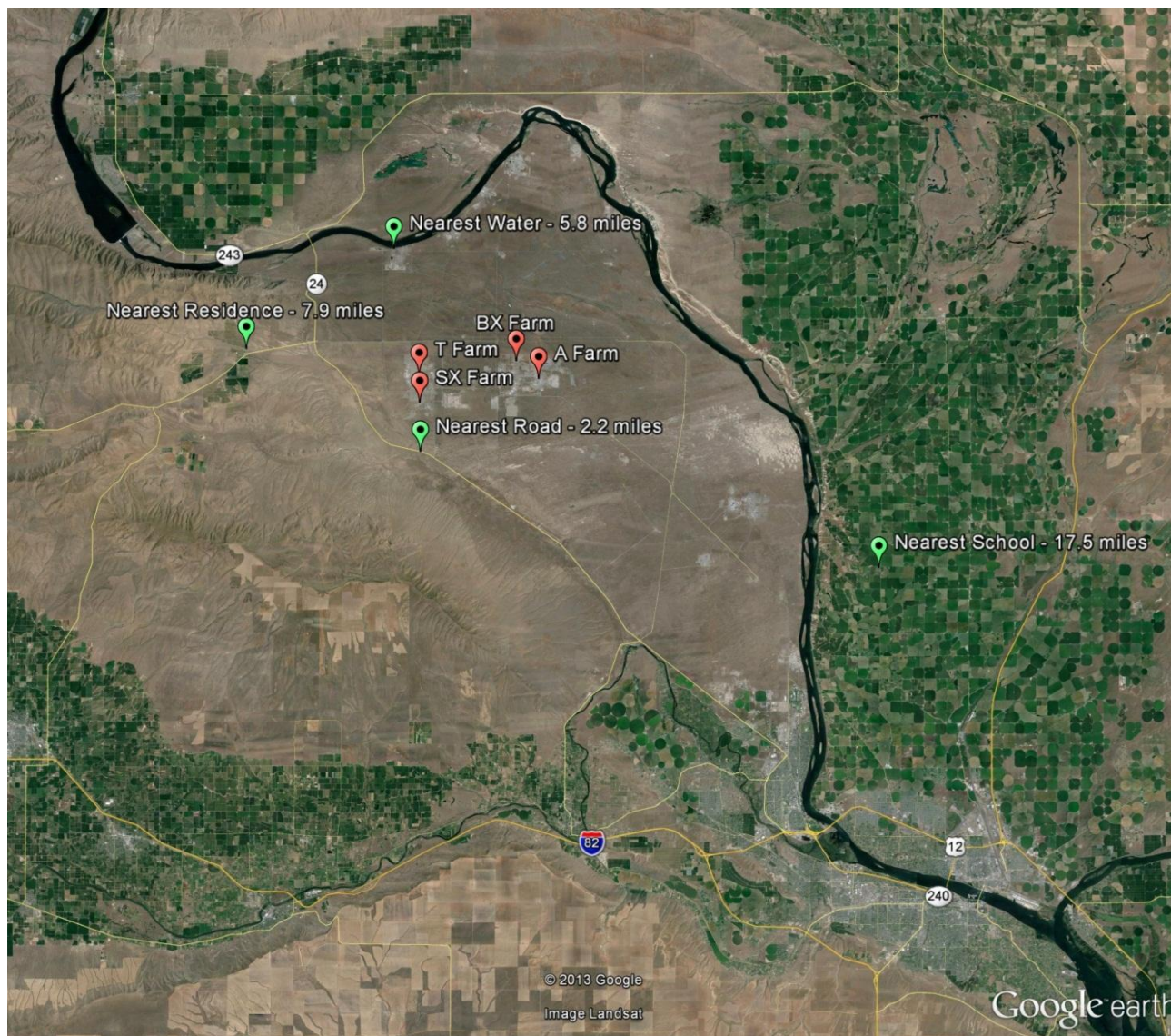
The Hanford Site is in the rain shadow of the Cascade Mountains and receives an average of less than seven inches of rain per year. The wind is predominately from the west, but calm wind conditions are frequent. Wind roses for the calendar years 2001-2005 were previously submitted to Ecology in RPP-ENV-48231, *Second Tier Review Petition for the Operation of the 241-SY, 241-AP, and 241-AY/AZ Tank Farm Ventilation System Upgrades*.

## **2.3 RECEPTORS**

As shown in Figure 1, the Hanford Site is very large. The locations where the public can be exposed to the exhaust emissions are shown in Figure 3. The nearest offsite location is along Highway 240 about 2.3 miles to the south of the SX Tank Farm. The areas to the south of Highway 240 are also controlled areas and not open to the public. The nearest resident is approximately 7.9 miles to the west from the T Tank Farm. The nearest water body is the Columbia River 6.8 miles to the north of the T Tank Farm. The nearest school is 17.5 miles to the south and east of the A Tank Farm.



**Figure 3. Map of the Hanford Area with Exhausters and Nearest Receptors.**



### 3.0 RESPONSIBLE MANAGER

The current responsible facility manager is:

Kevin W. Smith, Manager  
U.S. Department of Energy, Office of River Protection (ORP)  
P.O. Box 550  
Richland, Washington 99352  
(509) 372-2315

### 4.0 EMISSIONS AND ATMOSPHERIC MODELING

Emissions from the new core sampling systems were estimated based on previous tank headspace and ventilation system measurements that have been documented in the Tank Waste Information Network System (TWINS). The methodology is described below. Atmospheric modeling was conducted to estimate ambient concentrations as recommended by Ecology.

#### 4.1 EMISSIONS

The source term was submitted to Ecology in TOC-ENV-NOC-004, *Criteria & Toxic Air Emissions Notice of Construction for the Operation of the Core Sampling System in High Purge Gas Mode*, to develop the criteria and toxic air pollutant emissions for operation of the core sampling exhaust system in high purge gas flow mode was derived from NOC application RPP-ENV-48229, *Criteria & Toxics Air Emissions Notice of Construction for the Operation of the 241-AP, 241-SY, and 241-AY/AZ Tank Farm Ventilation System Upgrades* [Letter 11-NWP-121, “Re: Approval of Criteria and Toxic Air Emissions Notice of Construction (NOC) Application for the Operation of the 241-AP, 241-SY, and 241-AY/AZ Tank Farm Ventilation System Upgrades (Approval Order DE11NWP-001)”. The methodology used for this NOC application assumed the following:

1. When the maximum value in the TWINS database is the measurement detection limit, that value is assumed to be the reported value.
2. Measurements were made over a quiescent and passively ventilated tank for all SSTs and actively ventilated DSTs. A constant emission rate was assumed as long as the tank waste remained quiescent.
3. SSTs were passively ventilated during measurements and each DST ventilation system was assumed to have a flow rate for each tank of 1,000 standard cubic feet per minute (scfm) divided by the number of tanks in the tank farm.
4. The highest emission rate for each TAP, drawn from all tanks in the 200 Area East and West Tank Farm Facility, was used to establish a “worst case” tank.

The unabated emissions of criteria and toxic pollutants were estimated based upon measured headspace concentrations in the TWINS database. This database was searched for regulated criteria and toxic pollutants by the Chemical Abstracts Service (CAS) number for all tanks.



Tank ventilation flow rates were derived from HNF-3588, *Organic Complexant Topical Report*, Rev. 1. For tanks not listed in HNF-3588, Rev. 1, or where the tanks listed in HNF-3588, Rev. 1 are known to have previously been actively ventilated, ventilation flow rates from a similar type SST were used. Flow rates were converted to per-tank fluxes.

## 4.2 BEST AVAILABLE CONTROL TECHNOLOGY

Pursuant to WAC 173-460-060(2), *Control Technology Requirements* an analysis of Best Available Control Technology for Toxics (tBACT) for emissions of toxic pollutants was performed and it is reported in TOC-ENV-NOC-004, Appendix B.

A tBACT analysis was performed using the “top-down” approach established for BACT. This approach is defined in detail in *New Source Review Workshop Manual – Prevention of Significant Deterioration and Nonattainment Area Permitting*, EPA, 1990. The approach consists of the following steps:

- 1) Identify all control technologies
- 2) Eliminate technically infeasible options
- 3) Rank remaining control technologies by control effectiveness
- 4) Evaluate most effective controls and document results
- 5) Select BACT

Toxics with similar chemical and physical properties were grouped together with the assumption that similar control technologies would be effective. The four groups identified were:

- Ammonia
- Toxic organic compounds
- Mercury and mercury related compounds
- Particulate metal compounds

A detailed evaluation of the emission control technologies was performed, and after an effectiveness analysis a cost per ton of pollutant removed was calculated. All of the costs per ton were above \$9,700,000 per ton which exceeded the cost ceiling estimates of \$52,000 previously approved by Ecology and EPA for the Hanford Site as economically justifiable (RPP-ENV-46679). Due to the low emission rates the cost per ton to remove the pollutants becomes prohibitively expensive.

Based upon the results of this tBACT, the proposed tBACT control technology for the Core Sampling exhaust system is a HEPA filter and a 20 foot stack.

## 4.3 AIR DISPERSION MODELING

Ambient air concentrations at the Hanford Site boundary and beyond were estimated using the United States EPA AERMOD dispersion model, Version 12060. EPA-454/B-03-001, *User's Guide for the AMS/EPS Regulatory Model – AERMOD* and Ecology's *Guidance Document: First, Second, and Third Tier Review of Toxic Air Pollution Sources* (08-02-025) were used as modeling guidance.

The model inputs included the physical parameters of the stack, facility property line, and digital elevation maps. The surface meteorological inputs were from the Hanford Meteorological Station (HMS) and the upper air data was obtained from the Spokane, Washington, National Weather Service. Both sets of weather data have previously been checked for quality and used for modeling on the Hanford Site. The calendar years 2001-2005 were analyzed. Terrain data was from the United State Geological Survey for the surrounding area. The regulatory default mode was used for atmospheric concentrations. For atmospheric deposition the factors used are described in section 4.4.

The receptor grid space was:

**Table 2. Ecology Recommended Receptor Grid Spacing.**

<b>Distance from Source (m)</b>	<b>Grid Spacing (m)</b>
0 – 350	10
350 – 800	25
800 – 4,000	50
4,000 – 8,000	100
8,000 – 30,000	200

Only offsite receptors were modeled for this analysis.

Sampling at each of the four farms A, BX, T and SX were modeled separately and the highest off site receptor was used. An emission rate of one g/s was used. Table 3 shows the highest dispersion factors for the Core Sampler at each of the four farms separately. The receptor with the highest concentration for each time period is along Highway 240 to the south and west of the 241-SX Tank Farm.

**Table 3. Air Dispersion Factors for the Core Sampler System.**

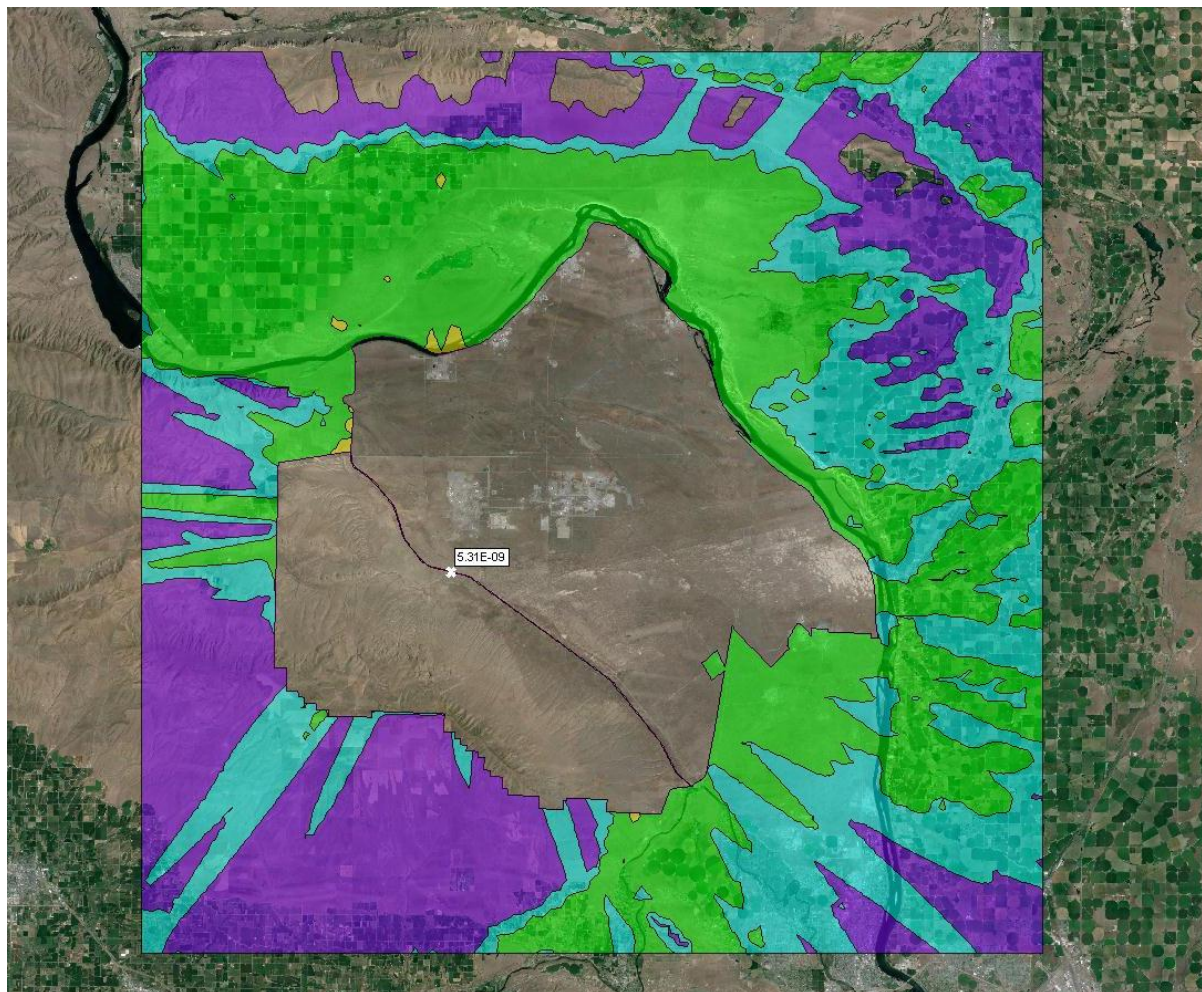
<b>Averaging Period</b>	<b>Dispersion Factor (<math>\mu\text{g}/\text{m}^3</math> per g/s)</b>	<b>Easting (m)</b>	<b>Northing (m)</b>
1-hour (241-SX Farm)	7.88E+01	297,459	5,153,842
24-hour (241-SX Farm)	8.90E+00	297,652	5,153,793
Annual (241-SX Farm)	3.22E-01	297,264	5,153,890

The air dispersion factors, based upon the specific TAP averaging period, were multiplied by the total emission rate in g/s to calculate the ambient air concentrations shown in Appendix B.

Of the 91 toxics identified 4 were found to be above the WAC 173-460 de minimis screening levels and 3 were found to be above the small quantity emission rate. Only DMM was found to be above the acceptable source impact level. The peak 24 hour modeled concentration for DMM was  $5.3\text{E}-09 \mu\text{g}/\text{m}^3$  in 2005 from 241-SX Farm. Figure 4 shows the location of the peak 24-hour concentration along Highway 240. The nearest residential receptor has a peak concentration of

1.3E-10  $\mu\text{g}/\text{m}^3$ . The nearest resident is impacted more than the highest commercial receptor so the resident scenario is assumed to be more conservative. The rest of this report focuses primarily on DMM.

**Figure 4. Contour Map of Peak 24-hour DMM Modeled Concentration from 241-SX Tank Farm for 2005.**



Domain Geodetic Coordinates		
Corner	Easting (m)	Northing (m)
NW	277,113	5,188,386
SW	276,968	5,128,495
NE	337,005	5,188,386
SE	337,005	5,128,495

Concentration ( $\mu\text{g}/\text{m}^3$ )	Contour Color
5E-09	Red
1E-09	Orange
5E-10	Yellow
1E-10	Green
5E-11	Cyan
1E-11	Purple

#### 4.4 DEPOSITION MODELING

Since DMM can deposit on vegetation and soil and that can be ingested, deposition was modeled. Dimethyl mercury is not water soluble and does not react to form particles as described in Section 5.4. Therefore, only gaseous deposition was modeled. The AERMOD default options for gaseous dry deposition were used to model DMM deposition. AERMOD also requires seasonal parameters, surface characteristics and gas physical parameters to model deposition. The seasonal categories that AERMOD uses to calculate dry deposition are:

1. Midsummer with lush vegetation
2. Autumn with unharvested cropland
3. Late autumn after frost or winter with no snow
4. Winter with snow on the ground
5. Transitional spring with partial green coverage or short annuals.

Based upon the climate for the Hanford area category One was used for the months of May, June, July, and August. Category Two was used for September and October. Category Three was used for November, December, January, and February. Category Four was used for March and April, and Category Five was not used due to the infrequency of lasting snowfall in the area.

AERMOD also requires land use to calculate dry deposition using the following land use options:

1. Urban land, no vegetation
2. Agricultural land
3. Rangeland
4. Forest
5. Suburban, grassy
6. Suburban, forested
7. Bodies of water
8. Barren land, mostly desert
9. Non-forested wetlands

The rangeland option was used for this project due to the dominance of shrub steppe in the area.

The transport and cycling of pollutants in the atmosphere are dependent on the physical properties of the pollutant. AERMOD also requires the following physical parameters of the gas to model the deposition:

1. Diffusivity in air:  $6.0\text{E-}02 \text{ (cm}^2\text{/s)}$  (Wesley et al., 2002)
2. Diffusivity in water:  $5.25\text{E-}06 \text{ (cm}^2\text{/s)}$  (EPA 530-R-05-006)
3. Leaf cuticular resistance:  $1.0\text{E}07 \text{ (sec/m)}$  (Wesley et al., 2002)
4. Henry's Law constant:  $6.0\text{E-}06 \text{ (pa-m}^3\text{/mol)}$  (Wesley et al., 2002).

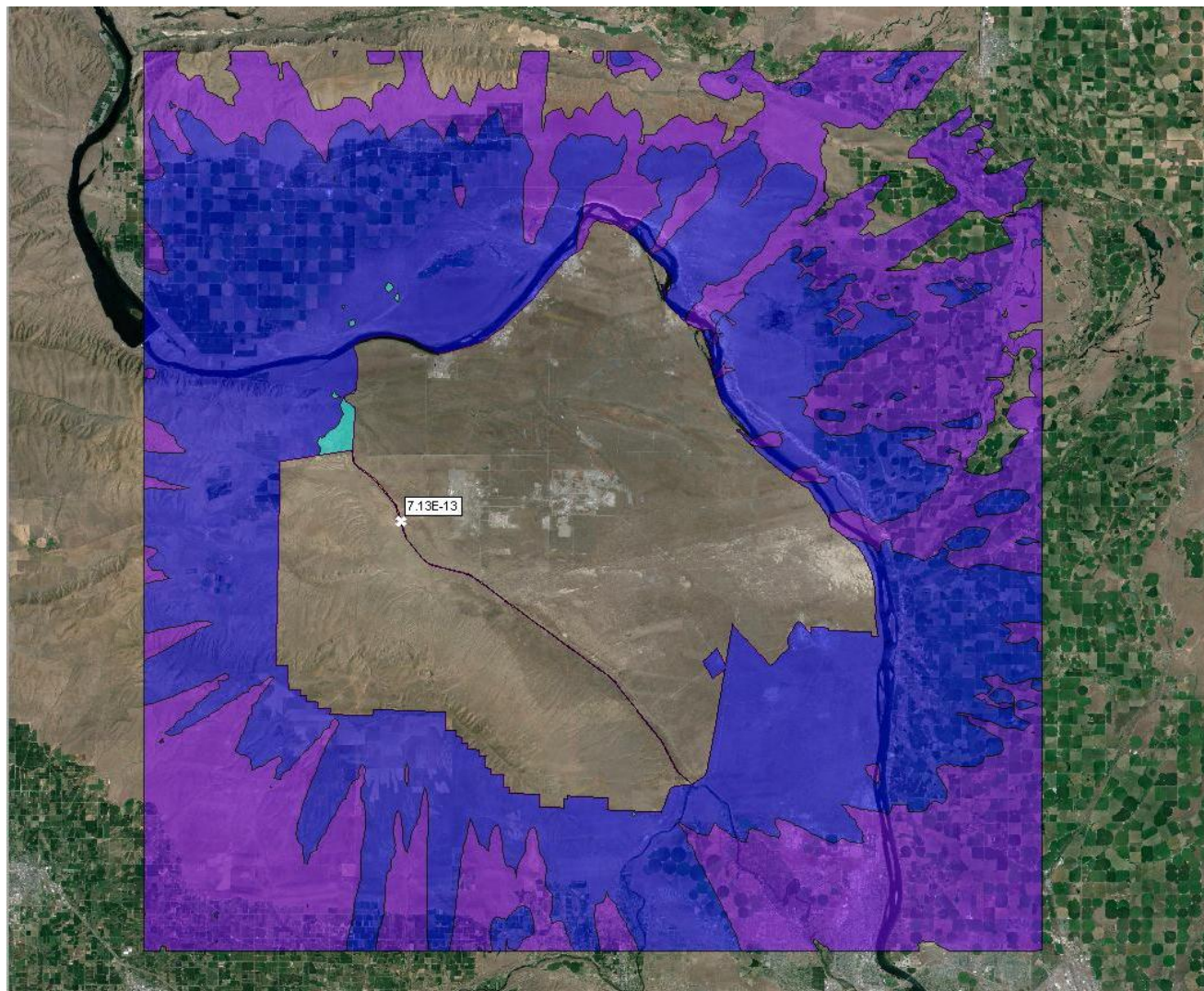
Only the 24-hour deposition values were modeled because the ASIL for DMM is 24-hours.

The peak 24-hour DMM deposition for the five year period was  $7.1\text{E-}13 \text{ g/m}^2$  for 2005 from 241-SX Farm. The location of the peak deposition point is also along Highway 240 to the west

of the 241-SX Tank Farm as shown in Figure 5. The peak deposition at the nearest residence is  $3.4\text{E-}14 \text{ g/m}^2$  for 2005.



**Figure 5. Contour Map for the Peak 24-hour DMM Deposition for 2005 from 241-SX Farm.**



## 5.0 HAZARD IDENTIFICATION

Hazard identification involves evaluating toxicity data from the emissions along with the health injury or disease that may occur due to exposure. Appendix C shows the 4 TAPs that were above the SQER screening level and a brief description of potential health effects. The information was obtained from the Centers for Disease Control web site (<http://www.cdc.gov/niosh/>) and State of New Jersey Department of Health web site (<http://www.ehso.com/ehso.php?URL=http%3A%2F%2Fwww.state.nj.us/health/eoh/rtkweb/>).

Dimethyl mercury is the only TAP above the ASIL and the only neurotoxin above the SQER. Therefore the balance of this analysis will focus on DMM.

### 5.1 DIMETHYL MERCURY

Dimethyl mercury is an organomercury compound that is very toxic to humans. A small skin exposure of a few drops has been lethal (Nierenberg, et al., *Delayed Cerebellar Disease and Death after Accidental Exposure to Dimethyl Mercury*, 1998). Due to its high toxicity, DMM is rarely used and only a few cases of DMM poisoning have been documented.

Dimethyl mercury is a colorless liquid that is volatile and insoluble in water. The physical properties of DMM are shown in Table 4.

**Table 4: Physical Properties of DMM.**

Property	Value
Melting Point (°C)	-
Boiling Point (°C)	96° @ 1 atm
Vapor Pressure (Pa)	8.3 x 10 <sup>3</sup> @ 25°C
Water Solubility (g/l)	2.95 @ 24°C
Henry's law coefficient	646 @ 25°C

Due to the scarcity of DMM toxicity data very few toxicity level recommendations are available. While only a few cases of DMM toxicity have been studied most have been fatal. Methyl mercury (MeHg) toxicity has been studied more extensively. There are many similarities between DMM toxicity and MeHg toxicity (ACGIH, *Mercury Alkyl Compounds*, 2001). Dimethyl mercury is metabolized to MeHg in the human body before it enters the brain (Ostlund, *Studies on the Metabolism of Methyl Mercury in Mice*, 1969) and is further converted to inorganic mercury in the brain. Since DMM is metabolized to MeHg, toxicity data from MeHg can be used to estimate the toxicity of DMM. There have been a few cases of MeHg poisoning due to people ingesting MeHg that had bioaccumulated in fish and also from grain tainted with MeHg used as a fungicide (NRC, 2000). The toxicity of organomercury compounds is different from inorganic mercury compounds in that organomercury compounds pass through the blood-brain barrier and the placenta very rapidly compared to inorganic mercury compounds (ACGIH, 2001).

The National Research Council (NRC) issued *Toxicological Effects of Methylmercury* in 2000 to analyze the literature and develop a reference dose for MeHg for the EPA. Methyl mercury,



unlike DMM, is soluble in water and bioaccumulates up the food chain. There have been documented cases of mass exposure of people to MeHg due to mercury poisoning of water bodies and the subsequent ingestion of fish. Two instances occurred in Japan. There was also a mass poisoning due to the ingestion of MeHg coated wheat in Iraq (NRC, Toxicological Effects of Methylmercury).

Methyl mercury is rapidly absorbed from the gastrointestinal tract and accumulates in the adult and fetal brain. Methyl mercury can cross the blood-brain barrier and is also able to cross the placental barrier exposing the fetus. In the brain the MeHg is slowly converted to inorganic mercury. Animal studies have indicated that the developing nervous system in fetal and young animals is the most sensitive target organ for MeHg exposure. The central nervous system effects are neuronal death leading to impairment of cognitive, motor, and sensory functions. The evidence for MeHg being carcinogenic is inconsistent and inconclusive (National Research Council, 2000). The responses to MeHg exposure are variable and uncertain.

The NRC determined that the population at the highest risk is children of women who consume large amounts of fish and seafood during pregnancy. The developing brain of the fetus is most susceptible to mercury poisoning. The NRC recommended a reference dose (RfD) of 0.1 µg/kg per day to protect pregnant women and developing fetuses based upon the available toxicity data. The NRC applied uncertainty factors of 3 each to pharmacokinetic variability and uncertainty and 3 for pharmacodynamic variability and uncertainty to the data, choosing an overall factor of 10 to arrive at the RfD of 0.1 µg/kg per day (EPA 2001 IRIS, <http://www.epa.gov/iris/subst/0073.htm>).

## 5.2 DIMETHYL MERCURY EMISSIONS

Mercury compounds are widely used and they are commonly disposed of in municipal incinerators and landfills. Inorganic mercury under anaerobic conditions common in landfills can be transformed into methylated forms (Compeau and Bartha, *Sulfate Reducing Bacteria: Principle Methylators of Mercury in Anoxic Estuarine Sediments*, 1985). Limited studies have been conducted looking at emissions of DMM from landfills. Lindberg et al., in Methylated Mercury Species in Municipal Waste Landfill Gas Sampled in Florida, USA, 2001, found mean concentrations of 30 ng/m<sup>3</sup> in landfill off gases in Florida. Seven landfills in Washington state were studied and landfill gas concentrations were found to be between 7.1 and 46.1 ng/m<sup>3</sup> (Gallagher and Bennett, *Determination of Total and Dimethyl Mercury in Raw Landfill Gas with Site Screening for Elemental Mercury at Eight Washington State Landfills for the Washington State Department of Ecology*, 2003).

## 5.3 BACKGROUND CONCENTRATIONS

Only a limited number of atmospheric measurements of DMM have been made. Measurements of DMM were made in Antarctica and are shown in Table 5 (de Mora et al., *Baseline Atmospheric Mercury Studies at Ross Island, Antarctica*, 1993).

**Table 5. Results from 196 Measurements of Atmospheric DMM in Antarctica.**

Measurement	Concentration (ng/m <sup>3</sup> )
Mean	0.04
Standard Deviation	0.08
Standard Error	0.01
Maximum	0.63
Minimum	0.00

An unknown number of ambient air concentrations in Seattle, Washington were measured to be  $0.003 \pm 0.004$  ng/m<sup>3</sup> (Prestbo et al., *A Global View of the Sources and Sinks for Atmospheric Organic Mercury*, 1996). Due to very limited data there are large uncertainties in background concentrations. The peak modeled 24-hour concentration is  $5.3\text{E-}09$  µg/m<sup>3</sup>, much lower than the measured background concentrations. A previous analysis of dimethyl mercury emissions from Hanford modeled a peak offsite 24-hour concentration of  $7.7\text{E-}08$  µg/m<sup>3</sup> (RPP-ENV-48231). Due to the much larger background concentrations including the background concentration in this analysis would increase the health risk and not provide any project-attributable information.

#### 5.4 ATMOSPHERIC FATE

Limited data is available about the concentration, fate, and transport of DMM in the atmosphere partly due to the very low concentrations and instrument detection limits. Reaction rate studies have shown that DMM will react with chlorine atoms (Cl), the hydroxyl radical (OH), the nitrate radical (NO<sub>3</sub>), ozone (O<sub>3</sub>), and fluoride radicals (F) (Sommar et al, *Rate of Reaction Between the Nitrate Radical and Dimethyl Mercury in the Gas Phase*, 1997). The reactions of DMM and Cl, OH, and NO<sub>3</sub> are the most dominant in the atmosphere. Given the atmospheric radical concentrations, the lifetime of DMM in the atmosphere ranges from roughly 1 to 100 hours (Sommar et al, 1997). Table 6 shows the lifetime of DMM in the atmosphere and the reaction products. Based upon this data the DMM from the Hanford Site is predicted to remain the vicinity of the Hanford Site. Therefore, no other forms of DMM were analyzed.

**Table 6: Atmospheric Lifetime of DMM and Hg Containing Products.**

Oxidant	Lifetime (hours)	Hg Products	Reference
Cl	1 - 100	CH <sub>3</sub> HgCl	Niki et al. 1983
OH	1.2 - 30	None detected	Niki et al. 1983
NO <sub>3</sub>	0.8 - 150	Hg or HgO	Niki et al. 1983
O <sub>3</sub>	80,000 – 1,100,000	HgO	Sommar et al. 1996

## 6.0 SENSITIVE POPULATION ANALYSIS

The area around Hanford has been restricted from public access since 1943 when the residents of the area were moved offsite. There are a limited number of people living even within 10 miles of the center of the site. A report of the population and demographics of people living around the Hanford site was conducted in 2004 based upon the 2000 Census (PNNL-14428, *Hanford Area 2000 Population*, 2004). A map of the Hanford Site with nearby cities and towns and their populations was submitted to Ecology in RPP-ENV-48231, *Second Tier Review Petition for the Operation of the 241-SY, 241-AP, and 241-AY/AZ Ventilation Systems*.

RPP-ENV-48231 also shows the shows the land use and zoning for the surrounding counties Benton, Franklin, and Grant. Based upon the AERMOD modeling results the area to the west of the and south were the highest concentrations are is zoned agricultural.

The point of maximum impact along Highway 240 to the south and west of the 241-SX Tank Farm was chosen for the 30 year mother-child exposure scenario and the nearest resident was chosen for the 70 year exposure scenario. The mother-child scenario is conservative since no one lives at that location and it was assumed that the peak concentration and deposition for 24-hours was the concentration for 30 years. The resident exposure also used the peak 24-hour peak concentration and deposition. The project is only scheduled to last 40 years and emissions were assumed to be at their maximum.

## 7.0 EXPOSURE ESTIMATION

Ecology and DOE decided that inhalation and ingestion pathways of exposure needed to be investigated (10-ESQ-378). This document follows the same methodology as has previously been submitted (Kadlec, M., Ogulie, D., Bowman, C., 2011). Since DMM is not water soluble, it was agreed that the water and fish intake pathway would not be investigated. The health risk assessment protocol followed was *The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (Hot Spots)* written by the California EPA in 2003.

Two scenarios were analyzed the mother-child pathway with the mother and child living along Highway 240 to the west of the 241-SX Tank Farm at the offsite receptor with the highest ambient concentration and deposition. To assess the mother-child pathway it was also assumed that the mother and child lived at that location for 30 years. The peak 24-hour concentration and deposition values were used to assess the 30-year exposure.

The second scenario analyzed was a person living at the site of the highest residential exposure to the west of the 241-SX Tank Farm for 70 years. The peak 24-hour concentration and deposition values were used to assess the 70-year exposure. Both scenarios were compared to the RfD to determine the most conservative exposure.

### 7.1 ESTIMATION OF EXPOSURE THROUGH INHALATION

The inhalation exposure to DMM was estimated using the CaliforniaEPA, guidance from 2003. Equation 5.4.1 was used to estimate the inhalation dose, is shown as Equation 1. The inhalation dose is a function of the air concentration and the respiration rate as defined in the following equation:

$$Dose_{inh} = \frac{C_{air} * DBR * A * EF * ED * 10^{-6}}{AT} \quad (1)$$

Where:

Dose <sub>inh</sub>	= Dose through inhalation (mg/kg/d)
C <sub>air</sub>	= Concentration in air (µg/m <sup>3</sup> )
DBR	= Daily breathing rate (L/kg body weight – day)
A	= Inhalation absorption factor (unitless)
EF	= Exposure frequency (days/year)
ED	= Exposure duration (years)
AT	= Averaging time period over which exposure is averaged in days

The California EPA recommended values for Equation 1 are:

DBR	= 271 L/kg body weight/day
A	= 1
EF	= 350 days
ED	= 30 and 70 years
AT	= 10,950 and 25,550 days

The modeling results show a peak 24-hour air concentration of 5.3E-09 µg/m<sup>3</sup> located along Highway 240 to the west of the 241-SX Tank Farm.

$$Dose_{inh} \frac{mg}{kg \text{ body weight} \cdot day} = \frac{5.3E-09 \frac{\mu g}{m^3} \cdot 271 \frac{L}{kg \text{ body weight} \cdot day} \cdot 1 \cdot 350 \frac{days}{year} \cdot 30 \text{ years} \cdot 10^{-6} \frac{mg}{\mu g}}{10,950 \text{ days}} \quad (2)$$

The result of Equation 2 for the mother-child scenario is an inhalation dose of 1.4E-12 mg/kg body weight per day which is 1.4E-09 µg/kg body weight per day. The result for the 70 year scenario is an inhalation dose of 3.4E-14 mg/kg body weight per day which is 3.4E-11 µg/kg body weight per day.

## 7.2 ESTIMATION OF EXPOSURE THROUGH INGESTION

The human exposure through food ingestion depends upon the amount of DMM that deposits on the plant while it is growing as well as the amount of DMM in the soil that the plant roots uptake. Next the human exposure depends upon the consumption of those plants. To calculate the human exposure it is first necessary to calculate the plant concentration.

The first step in the plant ingestion calculation is the estimation of the soil concentration. The California EPA guidance equation 5.32.A is:

$$C_s = \frac{Dep \cdot X}{K_s \cdot SD \cdot BD \cdot T_t} \quad (3)$$

Where:

$C_s$	= Average soil concentration over the evaluation period (µg/kg)
Dep	= Deposition on the affected soil area per day (µg/m <sup>2</sup> * day)
X	= Integral function
SD	= Soil mixing depth (m)
BD	= Soil bulk density (kg/m <sup>3</sup> )

The DMM deposition is from the AERMOD modeling results as explained above. The peak 24-hour deposition value was 7.1E-07 µg/m<sup>2</sup> day in 2005 located along Highway 240 to the west of the 241-SX Tank Farm. For the purposes of this analysis it was assumed that the most sensitive person was growing his/her garden at that location. For the nearest resident the deposition was 3.4E-08 µg/m<sup>2</sup> day in 2005. The California EPA recommended values for the SD is 0.15 m for an agricultural setting and the BD is 1,333 kg/m<sup>3</sup>.

The integral function described in Equation 3 is described in Equation 4 below:

$$X = \frac{e^{-K_s \cdot T_f} - e^{-K_s \cdot T_o}}{K_s} + T_t \quad (4)$$

Where:

$K_s$	= Soil elimination constant
$T_f$	= End of evaluation period (day)
$T_o$	= Beginning of evaluation period (day)

$T_t$  = Total days of exposure [ $T_f - T_o$ ] (days)

Using a 30-year exposure period the number of days for the total exposure is 10,950 assuming that the exposure began on day zero. Using a 70-year exposure period the number of days for the total exposure is 25,550 assuming that the exposure began on day zero. The soil elimination constant is given by equation 5.3.2 D in the California EPA document as:

$$K_s = \frac{0.693}{t_{1/2}} \quad (5)$$

Where:

0.693 = Natural log of 2  
 $t_{1/2}$  = Chemical specific soil half-life (days)

The soil specific half-life for DMM could not be found in the literature. Therefore Table 5.3 in the California EPA manual was used for inorganic mercury as 1E+08 days. The soil elimination constant then becomes:

$$K_s = \frac{0.693}{1E+08 \text{ days}} \quad (6)$$

The value of  $K_s$  is therefore 6.9E-09 /days. The integral function for the 30-year exposure then becomes:

$$X = \frac{e^{-1E+08 \text{ days} \cdot 10,950 \text{ days}} - e^{-1E+08 \text{ days} \cdot 0 \text{ days}}}{1E+08 \text{ days}} + 10,950 \text{ days} \quad (7)$$

The integral function is 0.42 for the 30-year exposure and 2.3 for the 70-year exposure. To calculate the soil concentration using Equation (3) the 30-year exposure calculation is:

$$C_s = \frac{1.9E-05 \mu\text{g}/\text{m}^2 \cdot \text{day} \cdot 0.42}{6.9E-09 / \text{day} \cdot 0.15 \text{ m} \cdot 1,333 \text{ kg}/\text{m}^3 \cdot 10,950 \text{ days}} \quad (8)$$

The 30-year exposure soil concentration of DMM is 1.9E-05 µg/kg assuming that the peak 24-hour deposition rate occurred over all 30 years of the analysis period. The 70-year exposure soil concentration of DMM is 2.2E-06 µg/kg assuming that the peak 24-hour deposition rate occurred over all 70 years of the analysis period.

Based upon the soil concentration it is possible to calculate the plant concentration. The two pathways for the DMM to enter the plant are direct deposition and through uptake of the roots.

To calculate the root uptake the California EPA manual suggests the following equation:

$$C_{uptake} = C_s * UF_2 \quad (9)$$

Where:

$UF_2$  = Uptake factor based upon soil concentration

The California EPA manual lists an equation for calculating  $UF_2$  for organic compounds, but the equation requires an octanol water partition factor as well as an organic carbon partition coefficient that could not be found in the literature. Therefore the octanol water partition coefficient for inorganic mercury was used. The highest root uptake factor was for leafy vegetables at  $9.0E-02$ . The 30-year exposure calculation is:

$$C_{uptake} = 1.9 E - 05 \mu\text{g/kg} * 9.0E - 02 \quad (10)$$

The calculated 30-year exposure root uptake concentration is  $1.7E-06 \mu\text{g/kg}$ . The calculated 70-year exposure root uptake concentration is  $2.0E-07 \mu\text{g/kg}$ . Next the deposition concentration of the plant is needed to calculate the total burden of DMM in the plant.

The equation for the deposition onto plants from the California EPA manual is:

$$C_{dep} = \frac{Dep * IF}{k * Y} * (1 - e^{-kT}) \quad (11)$$

Where:

IF = Interception fraction (unitless)  
 K = Weathering constant ( $\text{days}^{-1}$ )  
 Y = Yield ( $\text{kg/m}^2$ )  
 T = Growth period (days)

The California EPA guidance recommended values for the interception fraction for leafy crops is 0.2 the weathering constant is  $0.1 \text{ days}^{-1}$  and the growth period is 45 days. The 30-year exposure calculation is the following:

$$C_{dep} = \frac{1.9E-05 \mu\text{g/m}^2 * \text{day} * 0.2}{0.1 / \text{day} * 2 \text{ kg/m}^2} * (1 - e^{-0.1 \text{ day} * 45 \text{ days}}) \quad (12)$$

The 30-year exposure plant concentration due to deposition is then  $7.0E-07 \mu\text{g/kg}$ , the total plant concentration is  $2.5E-06 \mu\text{g/kg}$ . The 70-year exposure plant concentration due to deposition is then  $3.4E-08 \mu\text{g/kg}$ , the total plant concentration is  $2.3E-07 \mu\text{g/kg}$ .

To calculate the dose from ingestion of plants equation 5.4.3.3.a C in the California EPA guidance was used as shown below:

$$Dose - p = \frac{C_f * IP * GRAF * L * EF * ED * 10^{-6}}{AT} \quad (13)$$

Where:

$C_f$	= Concentration in plant (µg/kg)
$IP$	= Consumption of produce (g/kg*day)
$GRAF$	= Gastrointestinal relative absorption factor
$L$	= Fraction of produce homegrown
$EF$	= Exposure frequency (days/year)
$ED$	= Exposure duration (years)
$10^{-6}$	= conversion factor (µg/kg to mg/g)
$AT$	= Averaging time for exposure (days)

The 30-year exposure plant concentration is 2.5E-06 (µg/kg). The 70-year exposure plant concentration is 2.3E-07 (µg/kg). The California EPA recommended high end value for leafy produce is 10.6 g/kg body weight per day. A gastrointestinal absorption factor of one (i.e. assumes all DMM is absorbed into the body) was used as well as a factor of one for the fraction of produce homegrown. The exposure frequency was 350 days per year and the exposure duration was 30 years and 70 years. The averaging time for 30 years was 10,950 days and for 70 years it was 25,550. The 30-year estimated plant ingestion dose is 2.5E-11 mg/kg body weight per day. The 70-year estimated plant ingestion dose is 2.3E-12 mg/kg body weight per day.

### 7.3 ESTIMATION OF TOTAL EXPOSURE

The 30-year exposure total inhalation dose is 1.4E-09 µg/kg body weight per day and a total ingestion dose of 2.5E-08 µg/kg body weight per day the total dose is 2.6E-08 µg/kg body weight per day. The 70-year exposure total inhalation dose is 3.4E-11 µg/kg body weight per day and a total ingestion dose of 2.4E-09 µg/kg body weight per day the total dose is 6.9E-08 µg/kg body weight per day.



## 8.0 COMPARISON OF ESTIMATED EXPOSURE TO RISK

Hazard quotients were calculated for the maximally exposed individual including the residential, workplace and school receptors. A hazard quotient (HQ) is the ratio of the potential exposure of a person to a substance compared to the exposure level at which health effects are not expected.

$$HQ = \frac{\text{Total Exposure Dose } (\mu\text{g}/\text{kg body weight per day})}{\text{Corresponding Chronic Reference Dose } (\mu\text{g}/\text{kg body weight per day})}$$

Based on the reference dose recommended for MeHg of 0.1  $\mu\text{g}/\text{kg}$  body weight per day (NRC, 2000) and the 30-year exposure total dose of 2.6E-08  $\mu\text{g}/\text{kg}$  body weight per day the HQ is 2.6E-07  $\mu\text{g}/\text{kg}$  body weight per day. The 70-year exposure total dose of 2.4E-09  $\mu\text{g}/\text{kg}$  body weight per day the HQ is 2.4E-08. The 30-year and the 70-year exposure scenarios are well below the value of one indicating that the toxicological effects from DMM emissions from the Core Sampling System.

## 9.0 UNCERTAINTY ANALYSIS

Multiple factors of this HIA analysis contain uncertainty related to the lack of exact knowledge regarding the assumptions made to estimate the human health impacts. Due to the lack of toxicity data concerning DMM, there is a large uncertainty in the impacts resulting from exposure to DMM. Uncertainty can overestimate or underestimate the health risk.

### 9.1 RISKED BASED EXPOSURE CONCENTRATION

Very few instances of DMM exposure have been documented and those documented instances have been fatal therefore a dose response relationship has not been developed. For this analysis MeHg RfD was used since a RfD has been developed based upon a few studies. Since one study showed that DMM is converted in the MeHg (Ostlund, *Studies on the Metabolism of Methyl Mercury in Mice*, 1969). It was therefore concluded that the RfD for MeHg would be the best alternative RfD. The uncertainty is using a MeHg RfD instead of a DMM RfD is difficult to quantify due to a lack of data.

The MeHg developed by the NRC in 2000 listed two main categories of uncertainty: 1) biological variability in dose estimation and 2) data insufficiencies. The NRC applied a factor of 2-3 to account for biological variability and did not come up with a number for data insufficiencies but concluded that the overall uncertainty factor should be no less than 10.

### 9.2 EXPOSURE UNCERTAINTY

It is difficult to assess the length of time that people will be exposed to DMM emissions. The point of maximum exposure that was selected for this health impact analysis was along Highway 240, and it was assumed that someone lived at that location for the lifetime of the project. This assumption would overestimate the exposure.

The assumption that the DSTs would be sampled for the entire year would overestimate the exposure. It was also assumed that these three tank farms had DMM at the highest concentration found in all of the tanks, but only ten tanks have been found to have DMM.

The background level of DMM is also very uncertain due to its low atmospheric concentration and the limited number of measurements made.

### 9.3 EMISSIONS UNCERTAINTY

The exhauster emission estimates were based upon historical measurement data. The low concentrations of DMM in the headspace are near the analytical detection limits, so the uncertainty in the measurements leads to uncertainty in the emissions. The assumptions in these emission estimates represent a worst case situation.

### 9.4 AIR DISPERSION MODELING UNCERTAINTY

The transport and dispersion of pollutants in the atmosphere is complex and models developed to make many assumptions to solve the dispersion equations. Differences in the wind field over

the modeling domain can have large impacts on the modeled concentration. AERMOD is a regulatory model and is designed to be conservative in its estimate of concentrations.

## 10.0 CONCLUSIONS

A screening level risk assessment was conducted to determine whether the operation Core Sampler ventilation systems at the Hanford Site in south central Eastern Washington would likely threaten the surrounding area due to DMM emissions. A number of conservative assumptions were made to estimate the risk, so the potential impacts are likely overestimated.

- The emissions from the Core Sampling System were assumed to be at the highest emission rate from all tanks. Only 10 of the 177 tanks have had detectable concentrations of DMM.
- Two exposure scenarios were analyzed. First a 30-year exposure to a mother and child was analyzed at the point of highest atmospheric concentration and deposition along Highway 240. They were assumed to live at that location for 30 years. Second a resident living for 70 years was analyzed at the nearest residence 7.8 miles from the 241-SX Tank Farm.
- The ingestion rates were assumed to be the maximum according to guidance from the California EPA guidance.
- The maximum 24-hour concentration and deposition rates were assumed to be occurring for the entire 30 and 70 years of the analysis.
- The RfD used for the risk calculations includes a factor of 10 uncertainty factor to ensure that the hazard index is not underestimated.

These conservative assumptions made in this HIA resulted in an overestimation of the potential health impacts from DMM emissions. The calculated hazard quotient for a mother-child 30-year exposure is 2.6E-07, a level well below that threshold value of 1.0. The calculated hazard quotient for a 70-year resident exposure is 2.4E-08, a level also well below that threshold value of 1.0. Both of these hazard quotients indicate that DMM emissions from the proposed new sampling operation should not pose any threat to the public.

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**APPENDIX A**  
**Health Impacts Analysis Protocol Agreement Letters**



U.S. Department of Energy  
**Office of River Protection**  
P.O. Box 450, MSIN H6-60  
Richland, Washington 99352

10-ESQ-378

NOV 09 2010

1003862

Mr. D. Ogulei  
Air Quality Program  
Washington State  
Department of Ecology  
P.O. Box 47600  
Olympia, Washington 98504

Dear Mr. Ogulei:

**HEALTH IMPACTS ANALYSIS (HIA) FOR THE WASTE FEED DELIVERY EXHAUSTER  
UPGRADE PROJECTS FOR THE HANFORD DOUBLE-SHELL TANK (DST) SYSTEM**

Thank you for coming to the Hanford Site to meet with us on September 14, 2010, to discuss the Waste Feed Delivery Exhauster Upgrade Projects for the Hanford DST System HIA. The DST exhauster upgrades are an important element to providing Hanford Tank waste feed to the Waste Treatment and Immobilization Plant for vitrification and safe environmental disposal, and this work is being accomplished by funding made available under the American Recovery and Reinvestment Act.

The primary purpose of the meeting was to continue discussions on the process for development and submittal of a HIA required for approval of the DST exhauster Notice of Construction (NOC) application. Meetings were held on November 17, 2009, and June 18, 2010 in Lacey, Washington, which formed the basis for the pre-application conference as established by the Washington State Department of Ecology's (Ecology) guidance document (publication number 08-02-025, dated May 2009) for "First and Second Tier Review of Toxic Air Pollution Sources Health Impact Analysis." All meetings were conducted between Ecology, U.S. Department of Energy, Office of River Protection (ORP), and Washington River Protection Solutions LLC (WRPS) staff. At the November 17, 2009, meeting, discussions centered on an approach for conducting a HIA for only the SY DST exhauster. After further consideration, ORP and WRPS believe it is prudent to include all the currently proposed DST Exhausters in the analysis. This would include three exhauster systems: 1) 241-SY DST Farm; 2) 241-AP DST Farm; and 3) 241-AY/AZ DST Farms.

As discussed at the June 18, 2010, meeting, attached you will find the outline of information that is to be included in the HIA. Also included are specific areas that Ecology had indicated in the November 17, 2009, meeting, as being necessary for the development of the HIA. At the September 14, 2010, meeting, Ecology was provided the preliminary results obtained following the protocol outlined in the attachment to this letter. The HIA will be based on the performance specifications for the DST Exhauster Systems. ORP appreciates the offer to meet with WRPS staff to informally review the progress and content of the HIA prior to formal submittal for your Agency's approval.

Rcvd 11/11/2010



Mr. D. Ogulei  
10-ESQ-378

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**NOV 09 2010**

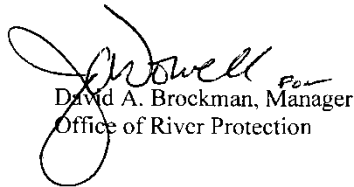
As agreed at the June 18, 2010, meeting, Ecology's Disposal Facility, located within the Hanford Site, will not be considered as an offsite receptor, as access to this site is controlled in the same manner as access to any other portions of the Hanford Site.

ORP would also like to consider how the results of this assessment can be applied to future NOC application revisions and submittals for all Hanford Site Tank Farm operations.

ORP would appreciate a response that the attached correctly outlines the guidance for a Second Tier Analysis.

If you have any questions, please contact me, or your staff may contact Thomas W. Fletcher, Tank Farms Project, (509) 376-3434.

Sincerely,



David A. Brockman, Manager  
Office of River Protection

ESQ:DWB

Attachment

cc: See page 3

Mr. D. Ogulei  
10-ESQ-378

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NOV 09 2010

cc w/attach:

D. W. Hendrickson, Ecology  
O. S. Wang, Ecology  
N. A. Homan, FHI  
Administrative Record  
BNI Correspondence  
Environmental Portal, LMSI  
WRPS Correspondence

cc w/o attach:

B. G. Erlandson, BNI  
J. Cox, CTUIR  
S. Harris, CTUIR  
B. Becker-Khaleel, Ecology  
K. A. Conaway, Ecology  
S. L. Dahl, Ecology  
S. L. Derrick, Ecology  
J. J. Lyon, Ecology  
D. Bartus, EPA (Region 10, Seattle)  
D. Zhen, EPA (Region 10, Seattle)  
G. Bohnie, NPT  
K. Niles, Oregon Energy  
D. Jackson, RL  
J. Martell, WDOH  
J. C. Allen-Floyd, WRPS  
W. T. Dixon, WRPS  
J. W. Donnelly, WRPS  
A. B. Dunning, WRPS  
T. A. Erickson, WRPS  
L. D. Garcia, WRPS  
A. M. Hopkins, WRPS  
G. J. Johnson, WRPS  
F. Miera, WRPS  
L. L. Penn, WRPS  
B. P. Rumburg, WRPS  
D. H. Shuford, WRPS  
S. M. Sax, WRPS  
R. J. Skwarek, WRPS  
C. G. Spencer, WRPS  
R. D. Wojtasek, WRPS  
R. Jim, YN

Attachment  
10-ESQ-378  
(3 Pages)

OUTLINE FOR THE HEALTH IMPACTS ANALYSIS SUBMITTED  
TO ECOLOGY FOR THE TIER II REVIEW AND APPROVAL FOR  
THE WASTE FEED DELIVERY DOUBLE-SHELL TANK  
EXHAUSTER UPGRADES NOTICE OF CONSTRUCTION  
APPLICATION

OUTLINE FOR THE HEALTH IMPACTS ANALYSIS SUBMITTED TO ECOLOGY FOR  
THE TIER II REVIEW AND APPROVAL FOR THE WASTE FEED DELIVERY DOUBLE  
SHELL TANK (DST) EXHAUSTER UPGRADES NOTICE OF CONSTRUCTION (NOC)  
APPLICATION

June 18, 2010 Lacey meeting participants:

Ecology: Dr. David Ogulei, Clint Bowman, Dr. Matthew Kadlec, Doug Hendrickson  
USDOE-ORP/ WRPS: Lori Huffman, Felix Miera, Todd Erickson, Dave Shuford,  
Brian Rumburg

September 14, 2010 Richland meeting participants:

Ecology: Dr. David Ogulei, Dr. Matthew Kadlec, Doug Hendrickson  
USDOE-ORP/WRPS: Phil Miller, Felix Miera, Todd Erickson, Dr. Brian Rumburg,  
James Bingham, Rick Wojtasek

1. Project description:

- a. Project details including schedule and duration of the project.
- b. Maps of the sources and the surrounding affected areas and the distances to nearby impacted residences, businesses/occupational (LIGO and Energy Northwest facilities), roadways, water bodies.

*NOTE: It was agreed that the U.S. Ecology Disposal Facility is not considered an off-site receptor as their employees are considered co-located and are badged by USDOE; access to the U.S. Ecology Facility is controlled the same as access to any other portion of the Hanford Site.*

- c. Location of emission points.

2. Hazard identification:

- a. A list of the maximum concentration (in ambient air) of all new or modified emissions of toxic air pollutants (TAPs).
- b. A comparison of the TAPs to the acceptable source impact level (ASIL).
- c. A physical description of all TAPs in excess of the ASIL.
- d. The transport and fate in the environment of the TAPs in excess of the ASIL.

3. Modeling methods and results:
  - a. AERMOD model details.
  - b. Source, dates, and data quality of meteorological data used – Use 5 year meteorological data.
  - c. The averaging periods for the modeling results will include the highest 1 hour, day and 1 year.
  - d. Geographical area modeled and grid spacing.
  - e. Modeling results including contour plots.
4. Identification of potentially exposed populations and susceptible subpopulations:
  - a. Locations and distances from the source to the following exposed people:
    - i. Residentially maximally exposed individual.
    - ii. Any sensitive sub-population maximally exposed individual.
    - iii. The offsite occupationally maximally exposed individual including exposures at Highways 24 and 240.
5. Exposure assessment:
  - a. Identification of the TAP exposure pathways.
  - b. Development of a total daily intake attributable to the source.
  - c. Background concentration estimates.
6. Toxicity:
  - a. Description of the toxic effects and exposure levels from the available scientific literature.
  - b. Exposure duration and pattern of exposure of toxic effects studies.
  - c. Quantitative chronic toxicity values.
  - d. Quantitative short-term toxicity values.
  - e. Consider confounding effects on studies cited.
7. Risk/hazard assessment:
  - a. The benefits to society from the project.
  - b. Qualitative discussion of the risks.
  - c. Quantitative discussion of the risks and the toxicity.
  - d. Discussion of the modeling uncertainties. (*NOTE: Need to include a narrative discussion in this section even if projected concentrations are at very low levels*)
    - i. Emissions uncertainties.
    - ii. Exposure uncertainties.
    - iii. Toxicity uncertainties.

- e. Discussion of the acceptability of the risk with regard to the documented studies and to WAC 173-460.
- f. Discussion of potential impacts of exposure to human health based on documented studies (e.g., studies provided by Ecology in item #6 above) and WAC 173-460 as appropriate.

**APPENDIX E**  
**Health Effects of Toxic Air Pollutants Above the SQER**

Table C-1. Health effects of TAPs above the SQER emission threshold.

Chemical Name	CAS#	Routes of Exposure	Target Organs	Acute Health Effects	Chronic Health Effects
Dimethyl Mercury	593-74-8	Inhalation Ingestion Skin Absorption	Central Nervous System	The substance is irritating to the eyes, the skin and the respiratory tract. The substance may cause effects on the central nervous system, resulting in impaired functions. Exposure may result in death. The effects may be delayed. Medical observation is indicated.	The substance may have effects on the central nervous system, resulting in impaired functions. This substance is possibly carcinogenic to humans. Causes toxicity to human reproduction or development.
n-Nitrosodimethylamine	62-75-9	Inhalation Ingestion Skin absorption Skin and/or eye contact	Liver Kidneys Lungs	Irritating to the eyes, skin, and respiratory tract. High exposure can cause headache, nausea, vomiting, stomach cramps, diarrhea, fever, and weakness.	Can damage the liver. The substance may have effects on the liver, resulting in jaundice, liver function impairment and cirrhosis. Probable carcinogen in humans, it has been shown to cause liver, kidney, and lung cancer in animals.
Chromium Hexavalent: Soluble	7440-47-3	inhalation, ingestion, skin and/or eye contact	Eyes, skin, respiratory system	May cause mechanical irritation to the eyes and the respiratory tract.	lung fibrosis